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supplying a gaseous mixture to the process chamber, the gaseous mixture comprising a silicon-containing gas, a fluorine-containing gas, an oxygen-containing gas, and a nitrogen-containing gas;

providing energy to the gaseous mixture to deposit a nitrogen-containing fluorinated silicate glass layer onto the substrate; and

forming a barrier layer over the nitrogen-containing fluorinated silicate glass layer.

2. (Amended) The method of claim 1 wherein the barrier layer comprises at least one of tantalum, tantalum nitride, silicon nitride, and silicon-carbon.

3. (Amended) The method of claim 1 further comprising forming a metal layer over the barrier layer.

4. The method of claim 3 wherein the metal layer comprises copper.

5. The method of claim 1 wherein the nitrogen-containing gas is selected from the group consisting of $N_2$, $N_2O$, $NH_3$, and $NF_3$.

6. The method of claim 1 wherein the silicon-containing gas comprises TEOS, the fluorine-containing gas comprises $SiF_4$, and the oxygen-containing gas comprises $O_2$.

7. The method of claim 1 wherein the gaseous mixture further includes an inert gas.

8. The method of claim 1 wherein providing energy comprises forming a plasma from the gaseous mixture in the process chamber.

9. The method of claim 1 wherein a ratio of a flow rate of the nitrogen-containing gas into the process chamber to a total flow rate of the gaseous mixture into the process chamber is less than about 10%.

10. The method of claim 1 wherein the nitrogen-containing fluorinated silicate glass layer has a nitrogen content of less than about 5 at. %.

11. The method of claim 10 wherein the nitrogen-containing fluorinated silicate glass layer has a nitrogen content of less than about 1 at. %.

12. The method of claim 11 wherein the nitrogen-containing fluorinated silicate glass layer has a nitrogen content of less than about 0.1 at. %.

13. The method of claim 12 wherein the nitrogen-containing fluorinated silicate glass layer has a nitrogen content of about 0.03-0.08 at. %.

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14. (Amended) A method for depositing a layer on a substrate having a barrier layer in a process chamber, the method comprising:

supplying a gaseous mixture to the process chamber, the gaseous mixture comprising a silicon-containing gas, a fluorine-containing gas, an oxygen-containing gas, and a nitrogen-containing gas; and

providing energy to the gaseous mixture to deposit a nitrogen-containing fluorinated silicate glass layer onto the barrier layer.

15. The method of claim 14 wherein the barrier layer is formed over a metal layer.

16. The method of claim 15 wherein the metal layer comprises copper.

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17. (Amended) The method of claim 14 wherein the barrier layer comprises at least one of silicon-carbon, silicon nitride, tantalum and tantalum nitride.

18. A method of forming a layer on a substrate in a process chamber, the method comprising:

forming a fluorinated silicate glass layer over the substrate;

forming a patterned photoresist layer over the fluorinated silicate glass layer;

etching the fluorinated silicate glass layer according to the patterned photoresist layer;

removing the photoresist layer and substantially simultaneously introducing nitrogen dopants into the fluorinated silicate glass layer by subjecting the photoresist layer and the fluorinated silicate glass layer to a plasma formed from a nitrogen-containing gas.

19. The method of claim 18 wherein the nitrogen-containing gas is selected from the group consisting of $N_2$ and $NH_3$.

20. The method of claim 18 wherein the nitrogen-containing gas comprises at least one of $N_2$ and $NH_3$.

21. The method of claim 18 wherein the plasma contains no oxygen species.

22. The method of claim 18 wherein nitrogen dopants are incorporated into the fluorinated silicate glass layer in a region near a surface of the fluorinated silicate glass layer which is exposed to the plasma formed from the nitrogen-containing gas.

23. The method of claim 22 wherein the region near the surface of the fluorinated silicate glass layer has a nitrogen content of less than about 10 at. %.

24. The method of claim 23 wherein the region near the surface of the fluorinated silicate glass layer has a nitrogen content of about 1 to about 5 at. %.

25. The method of claim 18 further comprising forming a barrier layer over the nitrogen-containing fluorinated silicate glass layer.

26. (Amended) The method of claim 25 wherein the barrier layer comprises at least one of silicon-carbon, silicon nitride, tantalum and tantalum nitride.

27. The method of claim 25 further comprising forming a metal layer over the barrier layer.

28. The method of claim 27 wherein the metal layer comprises copper.

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29. (Amended) A substrate processing system comprising:

a housing defining a process chamber;

a substrate support configured to support a substrate during substrate processing;

a gas delivery system configured to introduce gases into the process chamber, including sources for a silicon-containing gas, a fluorine-containing gas, an oxygen-containing gas, and a nitrogen-containing gas;

a plasma generating system;

a controller for controlling the plasma generating system, the gas-delivery system, and the pressure-control system; and